Info Note

Contributions of CCAFS research linking climate change and food and nutrition security

Summary of findings of the CCAFS Working Paper: A synthesis of the work of CCAFS and partners on climate change and food and nutrition security

Charles Nicholson, Laura Cramer, Philip Thornton

OCTOBER 2021

Key messages

- A recent synthesis documented the contributions of CCAFS and partners on the linkages between climate change and food and nutrition security (FNS).
- Of 68 documents identified by CCAFS and partners, 11 addressed linkages between climate change or climate-related interventions and FNS.
- CCAFS and partners made notable contributions to the development of conceptual frameworks, literature reviews, methods development, empirical assessment of linkages and the impacts of climate-smart agriculture on FNS.

CCAFS and partners have undertaken numerous activities and produced a considerable number of outputs of various kinds with the overarching goal to "catalyse positive change towards climate-smart agriculture, food systems and landscapes, and thereby contribute to the SLOs [System-level outcomes] on poverty alleviation, food and nutritional security." A recent synthesis of the work of CCAFS and partners on food and nutrition security (FNS) discusses the contributions in detail. The synthesis was developed based on written materials and consultations with the Program Management Unit, the Flagships' staff and CCAFS Regional programs. This note highlights the main contributions of CCAFS-supported work on food and nutrition security.

Approach for the synthesis

The synthesis employed a definition of FNS consistent with the definition in Committee for Food Security (CFS 2012):

> *when all people, at all times, have physical, social and economic access to food which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life.*

This definition encompasses each of four dimensions of "food security": availability, access, utilization and stability but extends it to consider factors known to affect FNS outcomes, such as sanitation, health services and other forms of care. The focus is on access (implied at an individual or household level) rather than on more aggregated measures of food availability such as the information in food balance sheets. Written materials summarized had substantive content on both climate change and FNS and involvement in the development of the output through CCAFS financial support or specific acknowledgment.

Overview of the synthesis findings

A total of 68 documents were reviewed in depth and each was summarized with information on the setting, objectives, methods, concepts related to climate change, nutrition and food security and their linkages, and key findings. Each work product was also classified based on six thematic areas (Table 1), with two areas of principal importance, 1) the impact of climate or climate change on FNS, or 2) the impacts of climate-related interventions (e.g. climate-smart agriculture (CSA)) on FNS. Impacts of climate change or climate-related interventions on potential correlates (such as yields, production or incomes) were included because some studies reviewed in depth focused on these outcomes. This classification also included five types of analysis or activities, e.g. empirical analyses using data versus the development of conceptual frameworks.

Table 1. Characterization of 68 studies reviewed in detail for the synthesis

Category of Output Theme	Type of Analysis:					
	Empirical Analysis	Conceptual Analysis	Literature Review	Descriptive (Elements separately described)	Methods Develop-ment	Total
Impact of Climate or Climate Change on FNS Outcomes	3	2	1		1	7
Impact of Climate or Climate Change on Potential FNS Correlates[a]	2			2		4
Impacts of Interventions on Climate Change	2					2
Impacts of Climate-related Interventions on FNS Outcomes	2	1	1			4
Impacts of Climate-related Interventions on Potential FNS Correlates[a]	1	1	1			3
Other, not in categories above	7	5	3	20	3	38
Other	2	4	1	2	1	10
Total	19	13	7	24	5	68

[a] *Potential FNS Correlates* include outcomes such as yields or production, which technically do not meet the criteria for inclusion but are summarized here because the studies were reviewed in depth based on initial review.

Note: *Empirical analysis* means that data were analyzed with one or more methods or that quantitative results were obtained. *Conceptual analysis* means that a framework linking elements was developed (not just application of a previous framework). *Literature review* is a broader discussion of linked elements based on previous literature, which typically would include both empirical and conceptual components. Descriptive work means that the document provided either empirical or conceptual information, but generally the elements characterized past or current status were discussed without linking different elements. *Methods development* includes work that evaluated methods of analysis or data collection.

With a relatively small amount of funding, CCAFS has supported or been acknowledged in a diverse body of work with meaningful contributions to understanding the linkages between climate change and food and nutrition security (FNS) outcomes. These include a range of publication formats (journal articles, working papers, Info Notes) and intended audiences (academic peers, policy makers, other stakeholders). CCAFS and partners have produced numerous outputs that directly address the impact of climate change on FNS or the impacts of interventions.

Development of novel conceptual frameworks linking climate change and FNS

Bryan et al. (2018) reviewed previous literature on pathways linking gender, climate and nutrition to develop an integrated gender, climate change, and nutrition (GCAN) conceptual framework. The GCAN framework can be used to guide integrated approaches to addressing multiple development challenges in the context of climate change by highlighting entry points for action, potential outcomes of various responses, and the trade-offs and synergies among outcomes. One key contribution is recognition that actions taken in response to climate shocks and stressors could influence well-being outcomes through six possible pathways: a) food production, b) income, c) asset dynamics, d) labor, e) natural resources, and f) cooperation. The framework also highlights what the authors note as the "considerable number of linkages, trade-offs, and synergies arise across alternative contexts or development outcomes, temporal scales, and different groups of people." It highlights the potential for "unintended consequences" of interventions and relationships and trade-offs between processes and outcomes.

The framework developed by Fanzo et al. (2017) adopts what it terms a "food systems" approach to "analyze the bidirectional relationships between climate change and food and nutrition along the entire food value chain." Thus, it emphasizes the need to consider the entire value chain rather than only agricultural production to understand the potential impacts of climate change and interventions on FNS. For example, it identifies potential impacts of climate change on food loss post-farm (affecting food availability and food access) and on the incidence of diarrhea (affecting food utilization). This document also identifies potential adaptation and mitigation interventions for each stage of the food value chain that could improve FNS outcomes. The framework focuses on lower-income rural farmers, a population especially vulnerable to the adverse effects of climate change on nutrition. Both of these conceptual frameworks are useful to guide further research because they explicitly recognize the potential for multiple impact pathways—many not related directly to yields or farm production that have been a focus in much previous literature—and thus multiple potential points of impact. They also highlight the need for more disaggregated analysis (e.g. different groups of farmers, consumers) and the need to consider both synergies and trade-offs. They thus usefully expand the scope for relevant research, although these frameworks alone cannot determine what pathways will be most important and which interventions the most effective at improving FNS.

Contributions to knowledge through literature reviews

Salm et al. (2020) reviewed the literature to understand how the concept of inequality was assessed when relating climate change to nutritional outcomes. It is widely recognized that climate change will affect vulnerable populations more, and this review synthesized existing knowledge related to the impacts on nutritional outcomes. The study adopted the PROGRESS+ methodology common in systematic reviews of health impacts, which evaluates the use of place, race, occupation, gender, religion, education and socio-economic status, among others. Moreover, they focused on studies that included nutrition-specific outcomes such as undernutrition, overweight-obesity, micronutrient deficiencies and diet-related non-communicable diseases. They found that many of the studies examined linkages between climate change and nutrition that were related to food security outcomes (e.g. food availability), but many fewer studies about climate impacts on capacity for childcare, health services, water and sanitation that can also be major drivers of nutrition outcomes. They also noted that there is limited information about how social factors affect the vulnerability of different groups or how representation of vulnerable groups in decision-making would contribute to improved nutritional outcomes.

A second review summarized by Ericksen et al. (2018) considered the empirical evidence about CSA and proposed a broadening of scope from CSA to a "climate-smart food system" that would include elements other than agricultural production—thus consistent with the framework from Fanzo et al. (2017). This poster reports on a systematic review of literature published between 2012 and 2017 evaluating the evidence about the impacts of CSA on food security, adaptive capacity and(or) mitigation. The review noted a number of limitations with the existing body of knowledge related to CSA more generally and to FNS more specifically. In particular, the report noted a) the limited number of crops and geographic areas studies, b) a focus on production (yields) but limited work on food security, adaptive capacity or mitigation, c) weak causal inference due to poor research designs, and d) reliance on simulation exercises (e.g. crop models) without "truly contextualized studies" that would enhance external validity. They also noted in the CSA evaluations the absence of a clear understanding of impact pathways leading to FNS. In response, they suggested the "broader view" of a climate-smart food system and more and better study designs to document CSA impacts and the trade-offs and synergies among the three pillars of CSA (increased productivity and income, reduction in contributions to climate change and increased resilience). This review is of great utility because it documents the rather limited evidence linking CSA—a key category of intervention supported by CCAFS work—to not only FNS outcomes but also to adaptive capacity and mitigation. The climate-smart food system concept appropriately links the general framework from Fanzo et al. (2017) to the evaluation of specific (CSA) interventions. *This study highlights the importance of a solid evidence base about the benefits of scaling CSA, including impacts on FNS.*

Contributions to the empirical assessment of linkages between climate change and FNS

Cooper et al. (2019) used a regression approach including the effects of spatial autocorrelation to evaluate the impact of precipitation on anthropometric measurements (weight-for-height z-score WHZ [wasting], height-for-age z-score HAZ [stunting] and household hunger scale (HHS) of variations in rainfall (a standardized precipitation index) in Ghana and Bangladesh. They found that only some of the rainfall variables (length of rainfall considered) were associated with differences in WHZ, HAZ and HHS and the effects differed in the two countries. A similar type of study by Duante et al. (no date) examined statistically the impacts of typhoons and droughts on recommended energy intake (REI) and chronic energy deficit in adults and wasting (WHZ) in children. This study used food security indicators as exogenous regressors, which limited the usefulness of the results for present purposes.

A different type of empirical analysis supported in part by CCAFS was modeling work by Mason-D'Croz et al. (2019). This study used the 'extended' IMPACT model framework to evaluate the impact of investments to improve agricultural productivity in sub-Saharan Africa at a regional aggregation level. This study used as metrics of the average food availability (kcal/person/day) and then the "prevalence of hunger" (although the article itself does not provide information about how food availability is converted to this latter measure). The study found that climate change will continue to slow projected reductions in hunger in the coming decades—increasing the number of people at risk of hunger in 2030 by 16 million in Africa compared to a scenario without climate change. Investments to increase agricultural productivity can offset the adverse impacts of climate change and help reduce the share of people at risk of hunger in 2030 to five percent or less in Northern, Western and Southern Africa, but the share is projected to remain at ten percent or more in Eastern and Central Africa.

Contributions to methods development for the assessment of climate change impacts on FNS

Cramer et al. (2017) proposes a framework and recommended methodologies and tools to measure how climate change and FNS affect one another. This working paper essentially documents a toolkit of methods that can be useful in making linkages between climate change and FNS. These include the development with stakeholders of food and nutrition scenarios, regionally aggregated modeling with IMPACT (and post-solve calculations), a gender toolbox, data collection tools such as RHoMIS (Hammond et al. 2018) and Climate-Smart Villages. For each, there is a description, a discussion of the type of results and outputs and implementation cases. Although this document does not directly apply the set of tools to analyze climate change-FNS linkages, it is a highly useful description of tools that could be used to explore those linkages. Duffy et al. (2017) also contributed to methods development by reviewing the metrics that could be used to assess outcomes from CSA. They motivate their work noting that it is necessary to have robust metrics and indicators for measuring progress towards CSA-related goals. They reviewed a range of gender, poverty, food security, nutrition and health indicators relevant for national planning processes for CSA promotion and scale out. Indicators related to FNS included prevalence of people undernourished, prevalence of child stunting and prevalence of child wasting. Description of the indicators is the focus, not assessment of linkages with climate change. Both of these studies are important because they address the statement in Duffy et al: “Gender, poverty, food security, nutrition and health indicators have not been extensively used in CSA programming and planning to date.” Studies by Müller et al. (2019 and 2020) are also relevant for methods development because they describe the co-design process with stakeholders for more actionable monitoring of seasonal hunger and the institutional and organizational factors that affect the use of FNS monitoring data in decision making.

Contributions to assessment of how climate-smart interventions affect FNS

The principal CCAFS output in this thematic area is the working paper by Radeny et al. (2018). This study employed quasi-experimental approaches to analyze the uptake and impact of CSA technologies (improved multiple stress-tolerant crop varieties, improved and better adapted livestock breeds and integrated soil and water conservation measures) promoted in Climate-Smart Villages (CSV) of Kenya. To evaluate FNS, they used the Household Dietary Diversity Scale (HDDS), which is a household-level measure of food access. Because baseline data were not collected outside the CSV, a preferred study design using difference in differences (DiD) was not possible, so Propensity Score Matching (PSM) was used for adopters and non-adopters of CSA technologies to assess impacts on HDDS. The study found rather modest impacts of adoption of stress-tolerant crop varieties (an increase of 0.5 in the HDDS value, equivalent to a mean increase of half a food group) but also noted in their assessment of the PSM results that “some of the critical values for hidden bias are quite low, indicating potential for hidden bias that would invalidate our findings.” Impacts of better-adapted livestock breeds and soil and water conservation measures did not improve HDDS by an amount statistically significant at the 5% level. *This study is important it suggests how future study designs might be improved, and documents that the FNS impacts of CSA are likely to vary and thus require empirical assessment.*

Further Reading

- Bryan, E., S. Theis, J. Choufani, A. De Pinto, R. Meinzen-Dick and C.Ringler. 2016. Gender-Sensitive, Climate-Smart Agriculture for Improved Nutrition in Africa South of the Sahara, CHAPTER 9 in A thriving agricultural sector in a changing climate: Meeting Malabo Declaration goals through climate-smart agriculture, eds. Alessandro De Pinto and Johh M. Ulimwengu, pp. 114-135 Washington, DC, IFPRI.
- Committee for Food Security. 2012. Global strategic framework for food security and nutrition. Food and Agricultural Organization.
- Cooper, M., M. E. Brown, C. Azzarri and R. Meinzen-Dick. 2019. Hunger, nutrition, and precipitation: evidence from Ghana and Bangladesh. *Population and Environment*, 41:151–208.
- Cramer, L. et al. (9 other co-authors). 2017. Methods Proposed to Evaluate the Potential Impact of Climate Change on Food and Nutrition Security in Central America and the Dominican Republic. CCAFS Working Paper no. 196. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org
- Duffy C, Murray U, Nowak A, Girvetz E, Corner-Dolloff C, Twyman J, Huyer S, Jarvis A and Spillane C. 2017. National level indicators for gender, poverty, food security, nutrition and health in Climate-Smart Agriculture (CSA) activities. CCAFS Working Paper no 195. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Ericksen, P., L. Cramer, P. Kromann, P. Henriksson, I. Brouwer, R. Remans, M. Constas and S. Coker. From Climate Smart Agriculture to Climate-Smart Food Systems? 2018. Poster for A4NH.
- Fanzo, J., R. McLaren, C. Davis, J. Choufani. 2017. Climate Change and Variability: What are the Risks for Nutrition, Diets, and Food Systems? IFPRI Discussion Paper 01645 May 2017.
- Hammond, James, Fraval, Simon, van Etten, Jacob, Suchini, Jose Gabriel, Mercado, Leida, Pagella, Tim, Frelat, Romain, Lannerstad, Mats, Douxchamps, Sabine, Teufel, Nils, Valbuena, Diego, van Wijk, Mark T., 2018. The rural household multi-Indicator survey (RHoMIS) for rapid characterisation of households to inform climate smart agriculture interventions: description and applications in East Africa and Central America. *Agricultural Systems*, 151, 225–233.
- Mason-D'Croz, D. et al. 2019. Agricultural investments and hunger in Africa modeling potential contributions to SDG2 – Zero Hunger. *World Development* 116 (2019) 38–53

- Nicholson CF. 2021. A synthesis of the work of CCAFS and partners on climate change and food and nutrition security. CCAFS Working Paper no. 369. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Radeny M, Ogada MJ, Recha J, Kimeli P, Rao EJO, Solomon D. 2018. Uptake and Impact of Climate-Smart Agriculture Technologies and Innovations in East Africa. CCAFS Working Paper no. 251. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Salm, L; Nesbitt, N.; Cramer, L.; Gillespie, S.; Thornton, P. 2020. How climate change interacts with inequity to affect nutrition; *WIREs Climate Change*. 2020; e696

This Info Note is part of the CCAFS Priorities and Policies for CSA Flagship work. It is based on the Working Paper: A synthesis of the work of CCAFS and partners on climate change and food and nutrition security.

About the authors:

Charles Nicholson *(cfn1@cornell.edu) is an Adjunct Associate Professor at the School of Integrative Plant Science, Cornell University, Ithaca, New York USA.*

Laura Cramer *(l.cramer@cgiar.org) is the Science Officer of the CCAFS Priorities and Policies for CSA Flagship.*

Philip Thornton *(p.thornton@cgiar.org) is the CCAFS Priorities and Policies for CSA Flagship Leader.*

About CCAFS Info Notes

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) brings together some of the world's best researchers in agricultural science, development research, climate science and Earth system science, to identify and address the most important interactions, synergies and tradeoffs between climate change, agriculture and food security. Visit us online at **https://ccafs.cgiar.org**.

CCAFS is led by the International Center for Tropical Agriculture (CIAT) and supported by: